

BRIEF COMMUNICATION

OTOLITHS AS POTENTIAL INDICATORS OF AGE IN COMMON CARP, *CYPRINUS CARPIO* L. (CYPRINIDAE: TELEOSTEI)

The common carp, *Cyprinus carpio* L., was among the first species of fish for which techniques of age estimation were developed¹. The annuli of scales (seasonal zones of slow growth) have been used as growth indicators in carp from Asia, Europe and North America²⁻⁵. Opercular bones⁶⁻⁸, fin rays⁹ and spines^{10,11} have proven useful, and the eye lens may also have value¹² although it is unreliable for older fish^{13,14}. Otoliths have been used successfully for the cyprinid *Phoxinus phoxinus*^{15,20}, but not for carp^{11,21}.

It is not clear whether the authors considered the full complement of otoliths in these studies. Carp, and teleost fish in general, have three pairs of utricular, saccular and lagenar otoliths, respectively named the lapilli, sagittae and asterisci. Given the peculiar morphology of the lower part of the inner ear of cyprinids (and other ostariophysan fish), the asterisci and the lapilli are much larger than the comparatively thin, elongate sagittae²². Lapilli have been used to distinguish daily growth increments in the fallfish *Semolilus corporalis*²³ and the rose bitterling *Rhodeus ocellatus ocellatus*²⁴, and a diurnal rhythm of calcium deposition has been reported in the asterisci of young goldfish *Carassius auratus*²⁵. Unspecified otoliths have been used to age tench, *Tinca tinca*, in Europe²⁶, but it is likely that these were asterisci or lapilli rather than sagittae.

In recent work on the ecology of carp we have been able consistently to recover well-formed otoliths with patterns that appear to represent a chronological record. As validation is necessarily a protracted procedure we believe that a preliminary communication is warranted. This work has special significance in Australia because carp are an introduced species that is widely believed responsible for the degradation of wetlands throughout the Murray-Darling Basin²⁷. If the impact of carp is to be evaluated the ability to estimate the ages of individual fish, providing for measurements of growth, recruitment and other population parameters, is crucial.

Samples for this study were obtained by gill-netting in backwaters of the River Murray at Swan Reach and at Gurra Gurra Lakes near Berri, from January to April 1994. Body weight (to within 0.1 g) and fork length (1 mm) were measured before recovering the otoliths and recording the weights of the asterisci (0.1 mg).

Annuli (translucent bands) were counted on the distal side of whole asterisci. When more than three annuli were present the earliest ones, particularly the first and second, were often obscured by calcium deposition. When more than 5-6 annuli were present the outermost ones were more easily discernible in transverse thin sections than in whole otoliths. The lapilli proved useful only when 2-3 annuli were present, and otherwise underestimated the counts from the asterisci. The sagittae showed no recognisable pattern. For these reasons, asterisci appear to be potentially more useful as indicators of age in this carp population.

In Figures 1a-c the asteriscus weight, fork length and body weight of 63 carp are plotted against the numbers of annuli on the asteriscus. Strong correlations are evident in each plot (respectively, Spearman rank correlation coefficient $r_s = 0.873$, $P < 0.001$; $r_s = 0.851$, $P < 0.001$, $r_s = 0.842$, $P < 0.001$), suggesting that the annuli are related to the size and weight of the fish and the weight of the asteriscus. The pattern of alternating translucent and opaque bands on the asterisci is comparable to that of other fish. The lapilli may provide complementary readings, especially where there are few annuli. We conclude that the asterisci, and to a lesser extent the lapilli, may provide a chronological record. Validation procedures are now underway to obtain data from fish of known age.

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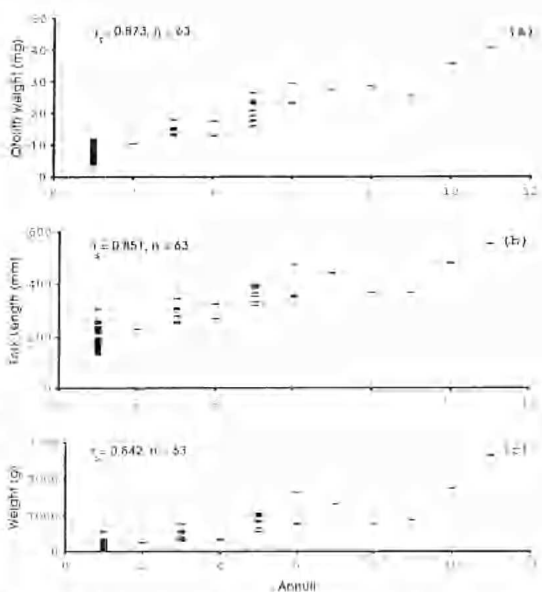


Fig. 1. Relationships between the numbers of annuli on the otoliths (asterisci) of carp from the River Murray, January-April 1994, (a) otolith weight (mg) (b) body size (Fork Length, mm), (c) body weight (g).

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